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*TB 9-6625-2138-35

DEPARTMENT OF THE ARMY TECHNICAL BULLETIN

CALIBRATION PROCEDURE FOR

DATA ERROR ANALYZER

HEWLETT-PACKARD, MODEL 1645A

Headquarters, Department of the Army, Washington, DC
8 January 1985

REPORTING OF ERRORS

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SECTION I

IDENTIFICATION AND DESCRIPTION

1. Test Instrument Identification. This bulletin provides instructions for the calibration of Data Error Analyzer, Hewlett-Packard, Model 1645A. The manufacturer's manual was used as the prime data source in compiling these instructions. The equipment being calibrated will be referred to as the TI (test instrument) throughout this bulletin.

*This bulletin supersedes TB 11-6625-2767-35, 25 January 1977, including all changes.

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a. Model Variations. Variations among models are described in text.

b. Time and Technique. The time required for this calibration is approximately 4 hours, using the dc and low frequency technique.

2. DA Form 2416 (Calibration Data Card)

a. Forms, records, and reports required for calibration personnel at all levels are prescribed by TB 750-25-1. DA Form 2416 must be annotated in accordance with TB 750-25-1 for each calibration performed.

b. Adjustments to be reported on DA Form 2416 are designated (R) at the end of the sentence in which they appear. When adjustments are in tables, the (R) follows the designated adjustment. Report only those adjustments made and designated with (R).

3. Calibration Description. TI parameters and performance specifications which pertain to this calibration are listed in table 1.

Table 1. Calibration Description

Test instrument parameters	Performance specifications
Frequency	Range: 74 to 9603 Hz Accuracy: ±0.03%
Dc voltage	Range: -23 to +15.5 V Accuracy: ±0.34%
Ac voltage	Range: -12 to +12 V peak Accuracy: ±3%

SECTION II

EQUIPMENT REQUIREMENTS

4. Equipment Required. Table 2 identifies the specific equipment to be used in this calibration procedure. This equipment is issued with Secondary Transfer Calibration Standards Set AN/GSM-286. Alternate items may be used by the calibrating activity when the equipment listed in table 2 is not available. The items selected must be verified to perform satisfactorily prior to use and must bear evidence of current calibration. The equipment must meet or exceed the minimum use specifications listed in table 2. The accuracies listed in table 2 provide a four-to-one ratio between the standard and TI.

5. Accessories Required. The accessories listed in table 3 are issued as indicated in paragraph 4 above and are used in this calibration procedure. When necessary, these items may be substituted by equivalent items, unless specifically prohibited.

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Table 2. Minimum Specifications of Equipment Required

Item	Common name	Minimum use specifications	Manufacturer and model (part number)
A1	AUTOTRANSFORMER	Range: 105 to 125 V ac Accuracy: ±1%	General Radio, Model W10MT3AS3 or Ridge, Model 9020F (7910809)
A2	DIFFERENTIAL VOLTMETER	Range: -23 to +15.5 V dc Accuracy: ±0.08%	John Fluke, Model 887AB/AN (887AB/AN)
A3	FREQUENCY COUNTER	Range: 74 to 9603 Hz Accuracy: ±0.007%	Hewlett-Packard, Model 5345A (MIS-28754/1 Type 1) w/5355A and K87-59992A
A4	OSCILLOSCOPE	Range: -12 to +12 V peak Accuracy: ±3%	Tektronix, Type R5440 (MIS-28706/1 Type 1) w/5A48 (MIS-28706/3) and 5B42 (MIS-28706/4)
A5	PULSE GENERATOR	Range: 0 to 1 kHz, 5 V peak Duty cycle: Adjustable to 40%	Hewlett-Packard, Model 214B (214B)

Table 3. Accessories Required

Item	Common name	Description (part number)
B1	ADAPTER	BNC T-type, 2 jacks, 1 plug (MS35173-274C)
B2	CABLE[1]	30-in., RG-58/U; BNC plug terminations (7907467)
B3	CLIP[2]	Single banana jack to alligator clip (red) (7907556)
B4	LEAD	24-in., No. 18; single banana plug terminations (red) (7907497)
B5	LEAD	24-in., No. 18; single banana plug terminations (black) (7907498)
B6	PROBE	Tektronix, Type P6006 (7913288)
B7	TERMINATION	50 Ω feed-through; BNC plug to BNC jack (11048B or 11048C)

[1]Four required.

[2]Two required.

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SECTION III

CALIBRATION PROCESS

6. Preliminary Instructions

a. The instructions outlined in paragraphs 6 and 7 are preparatory to the calibration process. Personnel should become familiar with the entire bulletin before beginning the calibration.

b. Items of equipment used in this procedure are referenced within the text by common name and item identification number as listed in tables 2 and 3. For the identification of equipment referenced by item numbers prefixed with A, see table 2, and for prefix B, see table 3.

WARNING

HIGH VOLTAGE is used or exposed during the performance of this calibration. DEATH ON CONTACT may result if personnel fail to observe safety precautions.

NOTE

Unless otherwise specified, verify the result of each test and, whenever the test requirement is not met, take corrective action before continuing with the calibration. Adjustments required to calibrate the TI are included in this procedure. Additional maintenance information is contained in the manufacturer's manual for this TI.

NOTE

When indications specified in paragraphs 8 through 12 are not within tolerance, perform the power supply check prior to making adjustments. After adjustments are made, repeat paragraphs 8 through 12. Do not perform power supply check if all other parameters are within tolerance.

NOTE

Unless otherwise specified, all controls and control settings refer to the TI.

7. Equipment Setup

a. Set switches as listed in (1) through (11) below:

(1) CLOCK to 9600.
(2) PATTERN to 1:1.
(3) EXPONENT RANGE to 2.
(4) SINGLE-CYCLE (PRINTER) to CYCLE (PRINTER).
(5) OFF-LOOP to LOOP.
(6) OFF-XMIT ERRORS to OFF.
(7) OFF-FILTER to OFF.
(8) EVENT to JITTER-TOTAL PEAK.
(9) JITTER-TOTAL PEAK to JITTER.
(10) DATA-$\overline{\text{DATA}}$ to DATA.
(11) DTR-RTS-BACKWARD CHANNEL to DTR.

b. Connect autotransformer (A1) to a 115-V ac source and adjust for 115 V.

c. Connect TI to autotransformer.

d. Set TI LINE, OFF-ON switch to ON and allow at least 3 minutes for warmup and stabilization.

8. Phase Lock Loop

a. Performance Check

(1) Connect oscilloscope (A4) to A14TP1 (fig. 1), using probe (B6).

(2) Adjust oscilloscope controls as required to view one complete cycle of waveform. If waveform does not have a 50 percent duty cycle, perform **b** below.

(3) Set PATTERN switch to (20)-1 and CLOCK switch to 75.

(4) Momentarily set START-STOP switch to START. Observe JITTER readout for one minute. JITTER readout indication will be 2 percent or less.

b. Adjustments. Adjust A14R16 (fig. 1) for an observed duty cycle of 50 percent (R).

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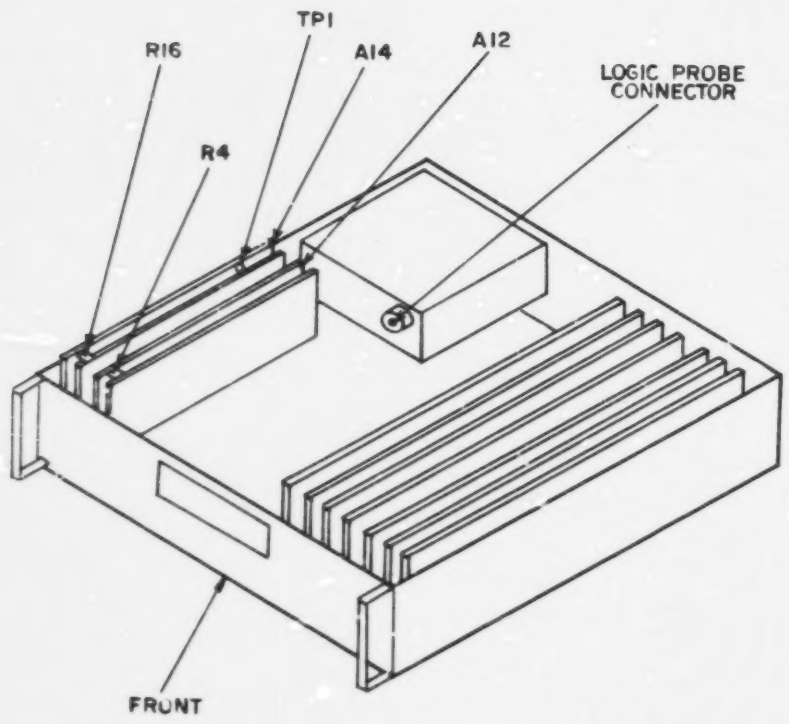

Figure 1. Test instrument - top view.

9. INT XMIT Clock

a. Performance Check

(1) Connect frequency counter (A3) to INT XMIT CLOCK connector (rear panel), using cable (B2).

(2) Remove TI top cover and set COUNT D/O COUNT C/L switch A1S1 (fig. 1) to COUNT D/O.

(3) Set CLOCK switch to settings listed in table 4. Frequency counter indications will be within limits specified.

(4) Set CLOCK switch to 9600.

(5) Connect INT XMIT CLOCK (rear panel) connector to oscilloscope (A4) input, using cable and termination (B2 and B7). Waveform amplitude will be no less than 2 V peak.

(6) Set PATTERN switch to 1:1 and OFF-LOOP switch to OFF.

(7) Connect BITS LOST connector (rear panel) to oscilloscope input, using cable (B2). Waveform amplitude will be no less than 1.5 V peak.

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Table 4. INT XMIT Clock Accuracy

Test instrument CLOCK switch settings	Frequency counter indications (Hz)	
	Min	Max
9600	9597.12	9602.88
7200	7128	7272
4800	4752	4848
3600	3564	3636
2400	2376	2424
1800	1782	1818
1200	1188	1212
600	594	606
300	297	303
200	198	202
150	148.50	151.50
75	74.25	75.75

(8) Connect frequency counter to BITS LOST connector, using cable (B2).

(9) Set CLOCK switch to 75. Frequency counter indication will be between 70 and 80 Hz.

(10) Observe that OUT OF LOCK and LOSS OF DATA (RCV DATA INV on some models) indicators are on.

(11) Set OFF-LOOP switch to LOOP. Frequency counter indication will be between 0 and 1 Hz.

b. Adjustments. No adjustments can be made.

10. Transmit Pattern

a. Performance Check

(1) Set switches as listed in (a) through (g) below:

(a) CLOCK to 9600.

(b) EXPONENT RANGE to AUTO.

(c) SINGLE-CYCLE (PRINTER on some models) to SINGLE.

(d) OFF-LOOP to OFF.

(e) OFF-XMIT ERRORS to XMIT ERRORS.

(f) EVENT to BIT ERROR.

(g) COUNT D/O COUNT C/L switch to COUNT C/L.

(2) Connect equipment as shown in figure 2.

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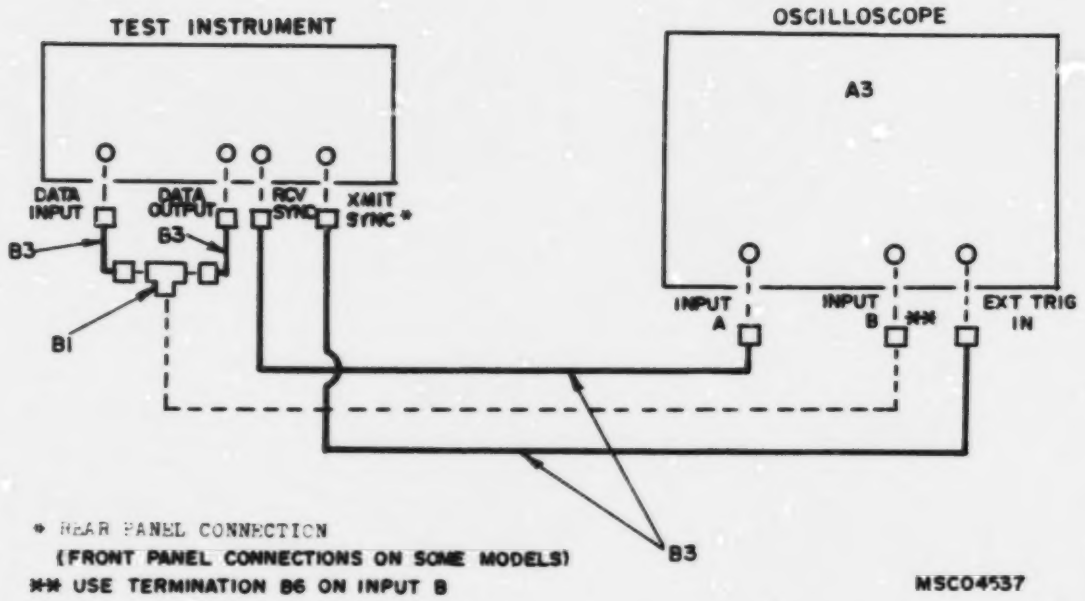

Figure 2. Transmit - equipment setup.

(3) Set PATTERN and DATA-$\overline{\text{DATA}}$ switches to settings listed in table 5. At each setting momentarily set START-STOP switch to START. Observe that TEST ON indicator is on while readout is counting, and then goes out when counting stops. After TEST ON indicator goes out, observe that readout and oscilloscope (A3) indications are as listed in table 5 and figure 3.

(4) Set PATTERN switch to MARK. Observe that OUT OF LOCK and LOSS OF DATA (RCV DATA INV) indicators are on. Oscilloscope channel 2 indication will be at least +2.5 V dc.

(5) Set DATA-$\overline{\text{DATA}}$ switch to $\overline{\text{DATA}}$. Oscilloscope channel 1 indication will be 0 V dc level.

(6) Set PATTERN switch to 1:1. Channel 1 waveform amplitude indication will be no less than 1.5 V peak.

b. Adjustments. No adjustments can be made.

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Table 5. Transmit Pattern Check

Test instrument							Channel 1 oscilloscope indications
Switch settings		READOUT indications					
PATTERN	DATA-$\overline{\text{DATA}}$	BIT ERROR	CARR LOSS	CLK SLIP	BLOCK ERROR	SKEW	
2047	DATA	EXP 488(±1)(-)6	EXP 0(-)6	EXP 0(-)6	EXP 488(±1)(-)3	---	Fixed bit[1] pattern
511	DATA	EXP 196(±1)(-)5	EXP 0(-)5	EXP 0(-)5	EXP 100(±1)(-)2	---	Fixed bit pattern
63	DATA	EXP 159(±1)(-)4	EXP 0(-)4	EXP 0(-)4	EXP 10(±1)(-)1	98%	Fixed bit pattern
63	$\overline{\text{DATA}}$	EXP 159(±1)(-)4	EXP 0(-)4	EXP 0(-)4	EXP 10(±1)(-)1	0%	Fixed bit pattern will be inverted
7:1[2]	$\overline{\text{DATA}}$	EXP 0(-)4	EXP 0(-)4	EXP 0(-)4	EXP 0(-)1	FLASHING	Fig. 3A
7:1	DATA	EXP 0(-)4	EXP 0(-)4	EXP 0(-)4	EXP 0(-)1	FLASHING	Fig. 3B
3:1	DATA	EXP 0(-)4	EXP 0(-)4	EXP 0(-)4	EXP 0(-)1	FLASHING	Fig. 3C
1:1	DATA	EXP 0(-)4	EXP 0(-)4	EXP 0(-)4	EXP 0(-)1	FLASHING	Fig. 3D

[1]Pattern will vary as PATTERN switch is adjusted.

[2]Set EXPONENT RANGE switch to 4.

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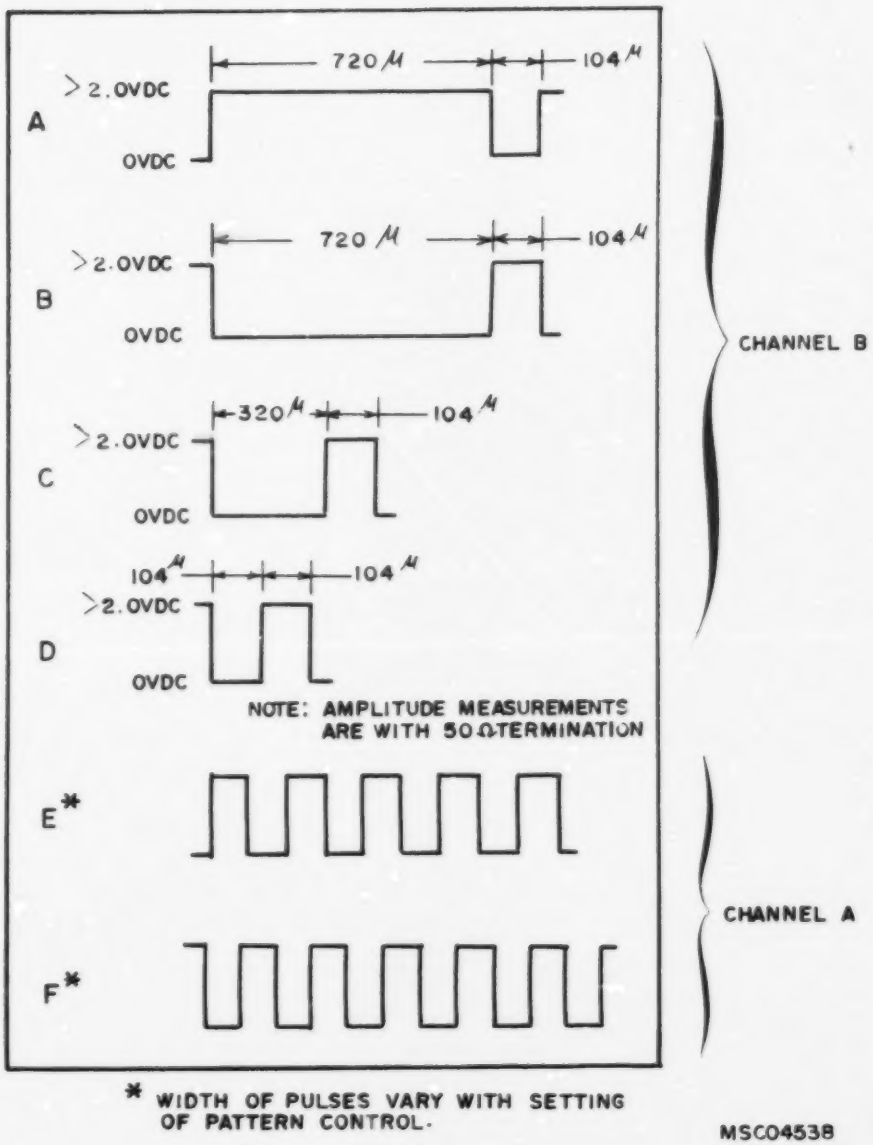

Figure 3. Transmit pattern waveforms.

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11. Jitter/Total Peak

a. Performance Check

(1) Set switches as listed in (a) through (e) below:

(a) EXPONENT RANGE to 2.
(b) SINGLE-CYCLE (PRINTER) to CYCLE (PRINTER).
(c) OFF-XMIT ERROR to OFF.
(d) EVENT to JITTER-TOTAL PEAK.
(e) JITTER-TOTAL PEAK to TOTAL PEAK.

(2) Remove top cover and set COUNT D/O COUNT C/L switch to COUNT D/O.

CAUTION

To prevent damage to circuitry, be sure RS232C interface board is installed in TI, and pulse generator (A5) is adjusted for minimum output before connecting as shown in figure 4.

(3) Connect equipment as shown in figure 4.

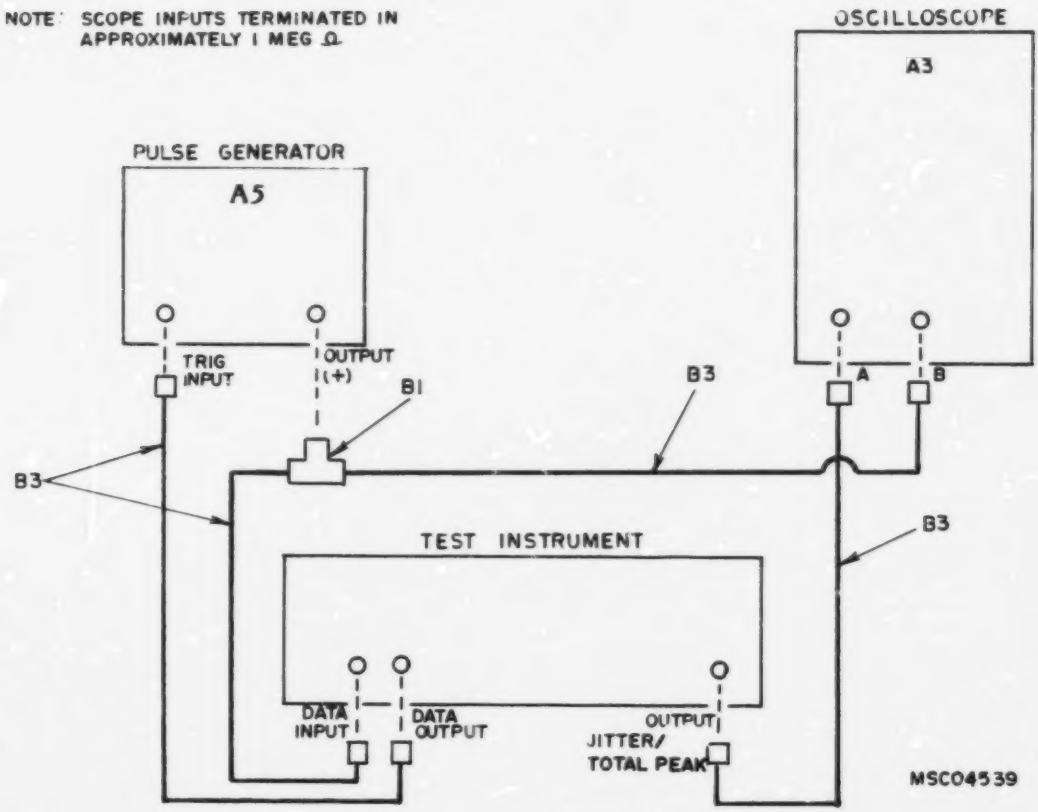

Figure 4. Jitter-total peak - equipment setup.

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(4) Adjust pulse generator for external triggered operation. Adjust output for +3 V peak and pulse width for 40 percent duty cycle as monitored on channel 2 of oscilloscope (A4). Damage of data input circuit will occur if this is not done. If digital readout is not between 18 and 22 percent and oscilloscope channel 1 waveform is not at least a 2-V p-p square wave, perform b below.

(5) Set JITTER-TOTAL PEAK switch to JITTER. Digital readout will indicate less than 2 percent.

(6) Set switches as listed in (a) through (c) below:

(a) CLOCK to 75.
(b) PATTERN TO (20)-1.
(c) OFF-LOOP to LOOP.

(7) Momentarily set START-STOP switch to START. Digital readout will indicate less than 2 percent and TEST ON indicator will flash on and off.

(8) Set switches as listed in (a) through (d) below:

(a) CLOCK to 9600.
(b) PATTERN to 1:1.
(c) OFF-LOOP to OFF.
(d) JITTER-TOTAL PEAK to TOTAL PEAK.

(9) Adjust pulse generator amplitude for +5 V peak. If digital readout does not indicate between 18 and 22 percent and oscilloscope channel 1 waveform is not at least a 2-V p-p square wave, perform b below.

(10) Set JITTER-TOTAL PEAK switch to JITTER. Digital readout will indicate less than 2 percent.

(11) Disconnect all equipment.

b. Adjustments. Adjust A12R4 (fig. 1) for a 2-V p-p square wave on oscilloscope channel 1, and a digital readout of 20 percent.

12. Dropout

a. Performance Check

CAUTION

To prevent damage to circuitry, be sure RS232 or RS232C interface board is installed.

(1) Set switches as listed in (a) through (f) below:

(a) PATTERN to 63.
(b) SINGLE CYCLE PRINTER to SINGLE.
(c) OFF-XMIT to XMIT ERRORS.
(d) EVENT to BIT ERROR.
(e) EXPONENT RANGE to CONT.
(f) DTR-RTS BACKWARD CHANNEL to DTR.

(2) Remove top cover and set COUNT D/O COUNT C/L switch to COUNT C/L.

(3) Observe indicator status to be as follows:

(a) OUT OF LOCK on.
(b) LOSS OF DATA on.
(c) DATA SET READY off.
(d) CLEAR TO SEND off.
(e) TEST ON off.
(f) BIT ERROR on.
(g) CARR LOSS off.
(h) BLOCK ERROR (RCV DATA) on.

NOTE

If block error light is not lit set loop switch to loop and back to off.

(4) Set LINE switch to OFF.

(5) Short pins on A15J1 connector on rear panel (DATA INTERFACE board RS232 or RS232C) as listed in (a) through (c) below:

(a) Pin 4 to pin 5.
(b) Pin 6 to pin 20.
(c) Pin 8 to pin 19.

(6) Set LINE switch to ON. TI indications will be as listed in (a) through (h) below.

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(a) OUT of LOCK on.
(b) LOSS OF DATA on.
(c) DATA SET READY on.
(d) CLEAR TO SEND off.
(e) TEST ON off.
(f) BIT ERROR on.
(g) CARR LOSS on.
(h) CLK SLIP off.

(7) Set DTR-RTS-BACKWARD CHANNEL switch to RTS. CLEAR TO SEND indicator will be on.

(8) Set DTR-RTS-BACKWARD CHANNEL switch to BACKWARD CHANNEL. CARR LOSS indicator will be off.

(9) Set LINE switch to OFF and remove shorts installed in (5) above.

(10) Set DTR-RTS-BACKWARD CHANNEL switch to DTR.

(11) Set LINE switch to ON.

(12) Connect differential voltmeter (A2) between pin 4 of A15J1 and chassis ground. Differential voltmeter indication will be between -5 and -12 V.

(13) Set DTR-RTS-BACKWARD CHANNEL switch to BACKWARD CHANNEL. Differential voltmeter indication will be between +5 and +12 V.

(14) Adjust pulse generator (A5) for oscilloscope (A4) indication as shown in figure 5A, and connect pulse generator output to BACKWARD CHANNEL DATA connector (rear panel), using cable (B2).

(15) Connect oscilloscope between pin 14 of A15J1 connector on rear panel (RS232C DATA INTERFACE) and chassis ground. Oscilloscope indication will be as shown in figure 5B.

(16) Remove top cover and set COUNT D/O COUNT C/L switch to COUNT D/O. Replace cover.

b. Adjustments. No adjustments can be made.

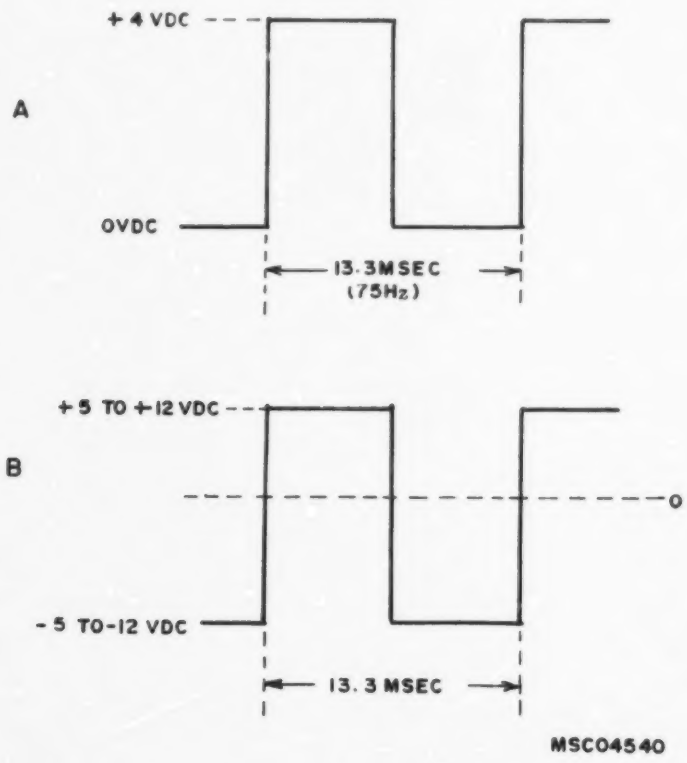

Figure 5. Dropout waveforms.

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13. Power Supply

NOTE

Do not perform power supply check if all other parameters are within tolerance.

a. Performance Check

(1) Connect differential voltmeter (A2) between +5V test point on A3 (fig. 6) and chassis ground, using leads and clips (B4, B5, and B3). Differential voltmeter indication will be between 4.95 and 5.05 V dc.

(2) Connect differential voltmeter between +15V test point on A3 (fig. 6) and chassis ground. Differential voltmeter indication will be between 14.5 and 15.5 V dc.

NOTE

Top cover of TI must be removed to gain access to LOGIC PROBE connector (fig. 1).

(3) Connect differential voltmeter between center conductor of +5V supply LOGIC PROBE connector and chassis ground. Differential voltmeter indication will be between 4.95 and 5.05 V.

b. **Adjustments.** No adjustments can be made.

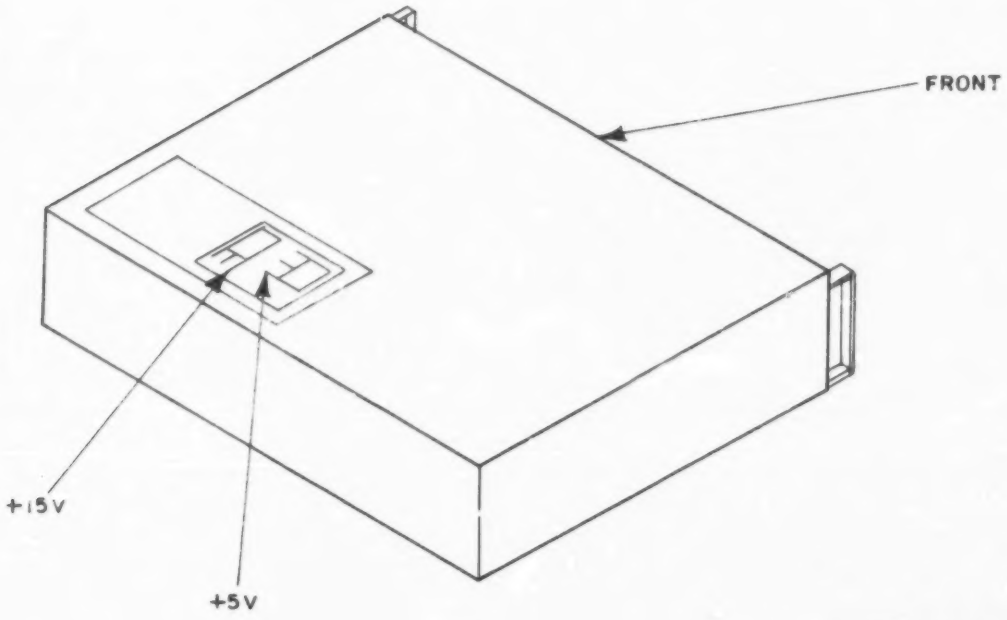

Figure 6. Test instrument - bottom interior view.

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14. Final Procedure

a. Deenergize and disconnect all equipment and reinstall protective cover on TI.

b. When all parameters are within tolerance, annotate and affix DA Label 80 (US Army Calibrated Instrument). When the TI receives limited or special calibration, annotate and affix DA Label 163 (US Army Limited or Special Calibration). When the TI cannot be adjusted within tolerance, repair the TI in accordance with the maintenance manual. When repair is delayed for any reason or the TI cannot be repaired with local resources, annotate and affix DA Form 2417 (US Army Calibration System Rejected Instrument) and inform the owner/user accordingly in accordance with TB 750-25-1.

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